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भाग 2 डायाफ्राम गैसमापी

Indian Standard

LEGAL METROLOGY — GAS VOLUME METERS

PART 2 DIAPHRAGM GAS METERS

ICS 17.120.10

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

December 1998

Price Group 7

Commercial Weights and Measures Sectional Committee, LM 06

FOREWORD

This Indian Standard (Part 2) was adopted by the Bureau of Indian Standards, after the draft finalized by the Commercial Weights and Measures Sectional Committee had been approved by the Light Mechanical Engineering Division Council.

The gas meters are used for measuring the gas consumption at the consumer's end, when the gas is supplied through pipelines. This standard covers the direct reading type diaphragm gas meters, to be used for gaseous fuels, for registering the volume of gas passed. This standard covers the different working ranges with maximum flowrates to suit the applicability. The maximum permissible errors at initial verification of the gas meters, as well as in service are also specified.

The standard provides the guidelines for test procedure, for pattern approval and subsequent verifications, to check conformity against the pattern approved. The accuracy tests are also prescribed, to check the accuracy at the defined maximum permissible errors at the specified flowrates.

This standard is based on OIML R 31 : 1989 'Diaphragm gas meters', issued by the International Organization for Legal Metrology (OIML). General requirements for the gas volume meters are covered in IS 14439 (Part 1) : 1997, which forms a necessary adjunct to this standard.

The standard on gas volume meters is being published in three parts as follows:

Part 1 General requirements,

Part 2 Diaphragm gas meters, and

Part 3 Rotary piston and turbine gas meters.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values *(revised)*'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

AMENDMENT NO. 1 DECEMBER 2008
TO
IS 14439 (PART 2) : 1998 LEGAL METROLOGY — GAS VOLUME METERS

PART 2 DIAPHRAGM GAS METERS

(*Second cover, Foreword, fifth para, first line*) — Substitute the following for the existing line:

'The standards on gas volume meters are of two parts'.

(*Second cover, Foreword, fifth para, last line*) — Delete the following existing line:

'Part 3 Rotary piston and turbine gas meters'.

(*Second cover, Foreword, fifth para*) — Add the following after the existing para:

'Due to publication of IS 15673 : 2006 Flow measurement of natural gas by rotary piston meters, IS 14439 (Part 3) : 1998 Legal metrology — Gas volume meters: Part 3 Rotary piston and turbine gas meters is to be withdrawn.'

(PG 26)

Reprography Unit, BIS, New Delhi, India

Indian Standard

LEGAL METROLOGY GAS VOLUME METERS

PART 2 DIAPHRAGM GAS METERS

1 SCOPE

This standard (Part 2) is applicable to gas volume meters in which the gas flow is measured by means of measuring chambers with deformable walls (diaphragm gas meters).

With regard to the gas volume meters defined above, this standard complements to IS 14439 (Part 1) : 1997 'Legal metrology — Gas volume meters : Part 1 General requirements', the requirements of which apply jointly with the requirements specified in this standard.

NOTE — In this standard diaphragm gas meters are called 'Gas meters' or 'meters'.

2 REFERENCE

The following Indian Standard contains provisions which through reference in this text, constitute provision of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

IS No.	*Title*
IS 14439 (Part 1) : 1997	Legal metrology — Gas volume meters : Part 1 General requirements

3 WORKING RANGE

3.1 The nominal values of maximum flowrates and the corresponding values of the upper limits of the minimum flowrates are given in Table 1.

3.2 A gas meter may have a lower value for the minimum flowrate than that shown in Table 1, but this lower value shall be one of the values shown in Table 1 or a decimal submultiple of one of those values.

4 DETAILS OF CONSTRUCTION

4.1 For each gas meter the difference between the calculated value of the cyclic volume and the nominal value (V) of this volume, indicated on the gas meter, shall not exceed 5 percent of the latter at reference conditions.

Table 1 Flow Rate Values

(*Clauses* 3.1 *and* 3.2)

Gas Meter Designation G	Q_{max} m^3/h	Upper Limit of Q_{min} m^3/h
0.6	1	0.016
1	1.6	0.016
1.6	2.5	0.016
2.5	4	0.025
4	6	0.040
6	10	0.060
10	16	0.100
16	25	0.160
25	40	0.250
40	65	0.400
65	100	0.650
100	160	1.000
160	250	1.600
250	400	2.500
400	650	4.000
650	1 000	6.500

4.2 Gas meters may be provided with a device to prevent the measuring device from functioning whenever the gas is flowing in an unauthorized direction.

5 TEST ELEMENT

5.1 General

For a gas meter equipped with an indicating device with an integral test element the standard deviation of the results of a series of at least 30 consecutive measurements of a volume of air equal to 10 times the nominal cyclic volume (20 times when 10 times the nominal cyclic volume is less than the volume corresponding to one revolution of the test element), carried out under identical conditions at a flowrate of the order of 0.1 Q_{max}, shall not exceed the values given in Table 2.

Table 2 Limit of Standard Deviation
(*Clause* 5.1)

Gas Meter Designation	Maximum Standard Deviation, dm^3
G 0.6 to G 6 inclusive	0.2
G 10 to G 65 inclusive	2
G 100 to G 650 inclusive	20

5.2 Test Element of a Mechanical Indicating Device

5.2.1 A mechanical indicating device may have either an integral test element according to the requirements specified in **6.2.2** of IS 14439 (Part 1), or a device which allows the fitting of a removable test element.

5.2.2 An integral test element of a mechanical indicating device shall have a maximum scale interval and a scale numbering according to Table 3.

Table 3 Scale Interval and Numbering
(*Clause* 5.2.2)

Gas Meter Designation	Maximum Scale Interval, dm^3	Numbering After Every, dm^3
G 0.6 to G 6 inclusive	0.2	1
G 10 to G 65 inclusive	2	10
G 100 to G 650 inclusive	20	100

6 MAXIMUM PERMISSIBLE ERRORS

6.1 Under the conditions laid down in **7** of IS 14439 (Part 1), the maximum permissible errors on initial verification and the recommended values for the maximum permissible errors in service are given in Table 4.

Table 4 Maximum Permissible Errors
(*Clause* 6.1)

Flowrate	Maximum Permissible Errors	
	On Initial Verification Percent	In Service Percent
$Q_{min} \leq Q < 0.1$ Q_{max}	±3	− 6, + 3
$0.1\,Q_{max} \leq Q$ Q_{max}	±1.5	±2

6.2 On initial verification the modulus of the errors for flowrates between 0.1 Q_{max} and Q_{max} in all shall not exceed 1 percent if the errors are all of the same sign.

6.3 The maximum permissible errors on initial verification apply to new gas meters and to gas meters submitted for verification after reconditioning or after the protective seals have been damaged.

6.4 When the maximum torques indicated on the gas meters pursuant to **4.3.2.1** or **4.3.2.2** of IS 14439 (Part 1) are applied to the drive shafts, the indication of the gas meter at Q_{min} shall not vary by more than 1.5 percent.

6.5 For a gas meter with a temperature conversion device and equipped with one indicating device, as defined in **6.1.1** (c) and **7.3** of IS 14439 (Part 1), the following applies.

6.5.1 No additional error for temperature conversion is allowed in an interval of 10°C. This interval is defined by a temperature specified by the manufacturer ±5°C. This interval shall be within the range of temperature of metering conditions marked on the data plate of the gas meter.

6.5.2 In each interval of 10°C subsequent (in either direction) to the interval meant in **6.5.1**, an additional error of 0.5 percent is allowed for temperature conversion.

6.5.3 Compliance with the requirement of **6.5.2** shall be verified at temperatures not more than 2°C from the extreme ends of the intervals specified above.

7 PRESSURE ABSORPTION

The total pressure absorption of a gas meter, averaged over a measuring cycle, with a flow of air of density 1.2 kg/m^3, at a flowrate equal to Q_{max}, shall not exceed the values given in Table 5.

Table 5 Pressure Absorption Values
(*Clause* 7)

Gas Meter Designation	Maximum Permissible Values for Average Total Pressure Absorption	
	On Initial Verification kg/cm^2	In Service kg/cm^2
G 0.6 to G 6 inclusive	200	220
G 10 to G 40 inclusive	300	330
G 65 to G 650 inclusive	400	440

NOTE — 'In service' values are recommended values.

8 PATTERN APPROVAL

Test procedures for pattern approval are specified in Annex A. The recommended form of pattern evaluation report is given in Annex B.

8.1 Application for Pattern Approval

At the same time as the pattern sample is submitted, the applicant shall place at the disposal of the Authority responsible for the examination from two to six sample gas meters manufactured in conformity with the pattern.

If so requested by the Authority responsible for the examination this number of gas meters should include different sizes if simultaneous approval of these sizes is requested; depending on the results of the tests, additional samples of gas meters may be required.

Notwithstanding the above requirements, the sample gas meters may be submitted at different times, but the decision on pattern approval shall be given only when all these samples have been received and examined.

8.2 Examination

8.2.1 The pattern and it's sample gas meters shall comply with the requirements of IS 14439 (Part 1) and with the requirements of **3**, **4**, **5**, **6** and **7** of this standard.

8.2.1.1 The errors of the sample gas meters shall be determined at seven flowrates evenly distributed through the working range.

8.2.1.2 At each flowrate the errors shall be determined at least six times independently by varying the flowrate between each pair of measurements. The standard deviation of the errors of indication shall be equal to or less than 0.2 percent for flowrates less than 0.1 Q_{max} and equal to or less than 0.1 percent for flowrates equal to or greater than 0.1 Q_{max}.

NOTE — These values correspond approximately to a bandwidth of 0.8 percent and 0.4 percent respectively.

8.2.2 In addition, the difference between the minimum and maximum of the error curve, as a function of the flowrate Q, shall not exceed 2 percent for the range from 0.1 Q_{max} to Q_{max}.

8.2.3 The pattern and it's sample gas meters are then submitted to a durability test.

8.2.3.1 The durability test is carried out:

a) For gas meters G 0.6 to G 10 inclusive: at the maximum flowrate, using gas for which the gas meter is intended to be used; and

b) For gas meters G 16 to G 650 inclusive : as far as possible at the maximum flowrate, using gas for which the gas meter is intended to be used. The flowrate during the test shall be at least equal to 0.5 Q_{max}.

NOTE — If the manufacturer demonstrates that the gas meter material is sufficiently insensitive to the gas composition, the approving authority may decide to perform the durability test with air.

8.2.3.2 The duration of the durability test shall be as follows:

a) For gas meters G 0.6 to G 10 inclusive : 2 000 h. The durability test may be discontinuous but shall be completed within 100 days; and

b) For gas meter G 16 to G 650 inclusive : such that each gas meter measures a volume corresponding to 2 000 h of operation of the gas meter at maximum flowrate. The test shall be completed within 180 days.

8.2.4 After the durability test, the gas meters (with the exception of one of them, if the durability test has been carried out on a minimum of three gas meters) shall comply with the following requirements.

8.2.4.1 The error curve shall be within the maximum permissible in service errors as specified in **6.1**.

8.2.4.2 Over the range from 0.1 Q_{max} to Q_{max} the difference between the minimum and maximum errors as a function of the flow 'Q' shall not exceed 3 percent.

8.2.4.3 The error values shall not differ by more than 1 percent from the initial corresponding values.

8.2.5 For patterns of gas meters with one or more drive shafts, at least three gas meters of each size shall be tested with air at a density of 1.2 kg/m^3 for compliance with the requirements of **4.3.2.4** of IS 14439 (Part 1) and **6.4** of this standard.

For patterns of gas meters with more than one shaft, the test shall be carried out on the shaft which gives the least favourable result.

For gas meters of the same size, the lowest torque value obtained in the tests shall be used as the maximum permissible torque value.

Where a type embraces gas meters of various sizes, the torque test need be carried out only on gas meters of the smallest size, provided that the same torque is specified for the larger gas meters and that the drive shaft of the latter has the same or a greater output constant.

8.3 Modification of an Already Approved Pattern

If the request for pattern approval concerns a modification to an already approved pattern, the Authority which approved the original pattern shall decide, according to the nature of the modification, whether and to what extent the requirements of **8.1** and **8.2** are applicable.

9 INITIAL VERIFICATION

Test detail for initial verification are given in Annex A (*see* **A-1** and **A-3**).

9.1 Examinations

9.1.1 Gas meters are examined and tested to ascertain whether they conform generally with their approved pattern.

9.1.2 Gas meters are examined and tested to ascertain whether they satisfy the requirements of IS 14439 (Part 1) and the requirements of this standard.

9.2 Accuracy Tests

A gas meter is considered to comply with the requirements concerning the maximum permissible errors if these are met at the flowrates Q_{min}, 0.2 Q_{max} and Q_{max}.

If the examination is conducted at different flowrates the assurance shall be at least equal to that obtained by the tests mentioned above.

10 SUBSEQUENT VERIFICATIONS

10.1 If gas meters are subject to subsequent verification, the time interval between subsequent verifications should preferably be 10 years.

10.2 Subsequent verification may be carried out using statistical sampling methods.

10.3 It is recommended that the in-service error limits be used for the reverification of gas meters with undamaged seals.

ANNEX A

(*Clauses* 8 *and* 9)

TEST PROCEDURES FOR PATTERN EXAMINATION AND INITIAL VERIFICATION OF DIAPHRAGM GAS METERS

A-1 TEST ROOM AND TEST INSTALLATION

A-1.1 General

A-1.1.1 The test room should be set up so that gas meters can be tested in a proper and efficient way.

A-1.1.2 The test room should be clean and in good order. Engines and other noise producing machines should be placed outside the test room.

A-1.2 Ambient Conditions

A-1.2.1 The average ambient temperature is defined as the arithmetic mean of the following temperatures:

- the ambient temperature near the reference standard(s),
- the ambient temperature near the meters to be tested,
- the air temperature at the air inlet of the test installation, and
- the ambient temperature near the place in the test room where the meters to be tested are stored prior to examination.

NOTE — The meters to be tested may also be stored in a neighbouring room with the same temperature conditions.

A-1.2.2 The conditions of the test room air shall be sufficiently stable. The demands at least that:

- the average ambient temperature does not change more than 4°C per 12 h and not more than 2°C per hour, and
- the temperatures mentioned in **A-1.2.1** should not differ mutually by more than 2°C.

A-1.2.3 If the following requirements are met, the meters may be tested without applying a correction for temperature difference between the reference meter and the meter to be tested:

- the air used to test the meters is at ambient conditions,
- the average ambient temperature does not change more than 2°C per 12 h and not more than 0.5°C per hour, and
- the temperatures mentioned in A-1.2.1 do not differ mutually by more than 0.5°C.

In all other cases corrections for temperature differences shall be made (*see* A-1.3.3).

A-1.2.4 The requirements with regard to temperature apply from 8 hours before the start of the first test until immediately after the last test.

A-1.2.5 During measurements the temperatures in the test room should be checked at least once a day.

A-1.2.6 The barometric pressure in the laboratory should be measured at least once a day.

A-1.3 Test Installation

A-1.3.1 *Test Air*

A-1.3.1.1 The test air should be clean and free of dust and oil.

A-1.3.1.2 The temperature of the test air should be within 0.5°C of the average ambient temperature.

A-1.3.1.3 The relative humidity shall be such that condensation is avoided at all times.

A-1.3.2 *Pressure Measurement*

A-1.3.2.1 Pressure tappings for meters under test should be located one pipe diameter upstream of the meter inlet and one pipe diameter downstream of the meter outlet. If this cannot be accomplished, the pressures actually measured shall be verified to be correct indications of the pressures at the above mentioned locations.

A-1.3.2.2 There should be a straight length of at least one pipe diameter upstream of the inlet pressure tapping and downstream of the outlet pressure tapping. The straight length at the inlet and at the outlet should be the same.

A-1.3.2.3 The holes for pressure tappings shall be perpendicular to the pipe axis. They shall have a diameter of at least 3 mm. The tappings shall not protrude into the gas flow. The inside wall of the pipe near the pressure tapping shall be smooth and free of burrs.

NOTE — In the case of one pipe connection, conditions laid down in **A-1.3.2.1** to **A-1.3.2.3** apply to the single pipes upstream and downstream of the so-called connection piece.

A-1.3.2.4 The pressure measuring device used to monitor the average pressure absorption of the meter under test shall average the usually varying pressure differential over the meter.

A-1.3.3 *Temperature Measurement*

The temperature representative of the measured gas volume should be measured at the outlet of the meter under test.

A-1.3.4 *Leakage*

Periodically the test installation should be tested extensively for leakage, both externally, that is into or out of the installation, and internally, that is through valves, etc. These leakage tests should be performed with the minimum or maximum operating pressure of the installation, whichever is applicable. The rate of leakage should be less than 0.1 percent of the minimum flowrate for which the installation is intended to be used.

A-1.3.5 *Series Testing*

If meters are to be tested in series, there should be no interaction between the meters. This condition may be verified by testing every meter of the series once at each position in the line.

A-1.4 Reference Standards

A-1.4.1 The test installation shall be equipped with reference standards that are suitable for the testing of diaphragm gas meters. The working range of the reference standards shall match that of the meters to be tested.

A-1.4.2 Manometers, thermometers, reference volume flow standards used to measure parameters that enter into the calculation of any quantity in connection with pattern approval or with initial verification shall have calibration certificates traceable to National or International Standards.

A-1.4.3 The certificates mentioned in **A-1.4.2** shall cover the range for which the instruments are used and shall report the calibration uncertainty.

A-1.4.4 The laboratory shall be able, at all times to specify the random and systematic uncertainty in the determination of the meter error.

A-1.4.5 The combined uncertainty in the determination of the meter error shall be at least a factor three smaller than the value of the maximum permissible errors for the meters tested.

A-2 PATTERN APPROVAL

A-2.1 Documents and meters to be submitted.

A-2.1.1 The applicant shall submit the documents as specified in **12.1.3** of IS 14439 (Part 1).

A-2.1.2 The applicant shall submit a number of meters for examination according to **8.1**.

A-2.1.3 The documents shall be examined to verify that they are in accordance with the meters submitted.

A-2.2 General Inspection

A-2.2.1 The markings and inscriptions on the meters shall be examined in accordance with **4.3.1**, **4.3.2.1** or **4.3.2.2**, **5.1** and **6.1.1.3** of IS 14439 (Part 1). The working range indicated shall comply with **3.1** of this standard.

A-2.2.2 The places provided for verification marks and protection marks shall be checked in accordance with **9** of IS 14439 (Part 1).

A-2.2.3 The indicating device(s) shall be checked according to **6.1** of IS 14439 (Part 1). The test element(s) shall be checked according to **6.2** of IS 14439 (Part 1) and **5** of this standard.

A-2.2.4 The meters to be tested should be ready for operation according to the manufacturer's operating instructions.

A-2.2.5 Meters having additional devices should be checked to ensure that these devices are connected properly and that they conform to the documents supplied by the manufacturer (*see* **A-2.4** and **A-2.5**).

A-2.3 Initial Performance Test at Ambient Conditions

A-2.3.1 *Error Curve*

A-2.3.1.1 Meters shall be stabilised at the temperature of the test room.

A-2.3.1.2 Meters shall be installed on the test installation in accordance with the manufacturer's operating instructions. Pipes connected to the inlet and outlet of the meter should be of the same nominal sizes as those of the meter connections.

A-2.3.1.3 After the meter is installed on the test installation it is brought to the minimum or maximum gauge pressure of the test installation, whichever is applicable.

When temperature is stable the leak rate shall be less than 0.1 percent of the lowest flowrate at which the meter will be tested

A-2.3.1.4 Before the start of the testing, the meter should be run in at maximum flowrate. The volume passed through the meter should be at least 50 times the cyclic volume of the meter. The actual duration of running-in may depend on the time that has elapsed since the meter was last in operation.

A-2.3.1.5 The error curve of all meters submitted shall be determined, at least, at seven flowrates. These flowrates shall include: Q_{max}, 0.7, Q_{max}, 0.4, Q_{max}, 0.2, Q_{max} 0.1, Q_{max} 3 Q_{min} and Q_{min}.

A-2.3.1.6 The meter should be tested preferably with a volume of air that equals an integer multiple of the cyclic volume of the meter. If this is not possible the volume of air passing through the meter should be chosen so that the influence of the variation of the cyclic volume is smaller than 0.2 percent for the tests at flowrates equal to or greater than 0.1 Q_{max} and 0.4 percent for the tests at flowrates less than 0.1 Q_{max}.

A-2.3.1.7 If a number of meters are examined in series the average inlet pressure at each meter should be measured in order to be able to account for the effect on the measured volume of the decreasing pressure in the test line.

A-2.3.1.8 The error at each flowrate is determined as the mean value of the errors, at least at six measurements, three with decreasing flowrate and three with increasing flowrate.

A-2.3.1.9 The error at each flowrate shall be within the maximum permissible errors specified in **6.1** and **6.2**.

A-2.3.2 During the test at Q_{max} the pressure differential between the inlet and the outlet of the meter shall be read for the determination of the average total pressure absorption of the meter (*see* **7**).

A-2.3.3 To be able to detect mechanical wear occurring during the durability test the pressure absorption at Q_{min} should be determined.

A-2.3.4 The standard deviation of the indication of each of the submitted meters shall be determined according to **8.2.1.2**.

A-2.4 Performance Test at Temperatures Other than Reference Temperature

A-2.4.1 If the approving authority decides to check the meter performance over the range of metering temperatures as specified on the meter according to **5.1**(i) of IS 14439 (Part 1) the meters should be tested at least at the following temperatures:

- a temperature within 5°C from the minimum metering temperature, and
- a temperature within 5°C from the maximum metering temperature.

NOTE — The reference standard shall always run at a temperature for which its calibration is valid.

A-2.4.2 The temperatures of the meter ambience and of the test air at the meter inlet shall be within 0.5°C at a given temperature setting.

The temperature shall be fully stabilized before testing at a given temperature. The temperature shall be measured.

NOTE — The humidity of the test air shall be such that no condensation occurs.

A-2.4.3 The test shall be performed at 0.2 Q_{max}, 0.7 Q_{max} and Q_{max} flowrates.

A-2.4.4 The errors at each test temperature shall be within the maximum permissible errors specified in **6.1** and **6.2**.

A-2.5 Additional Devices

A-2.5.1 If the meter is equipped with a prepayment device it shall be verified that this device has no significant influence on the meter performance [*see* **4.3.1** of IS 14439 (Part 1)].

A-2.5.2 If the meter is equipped with a pulse generator, its proper working and the number of pulses per unit volume shall be checked [*see* **4.3.1** of IS 14439 (Part 1)].

A-2.5.3 A meter equipped with output drive shafts shall be checked according to **8.2.5** to verify that the connection between the measuring device and the gearing remains intact when a torque of three times the maximum torque M_{max} is applied [*see* **4.3.2.4** of IS 14439 (Part 1)]. Likewise the error at Q_{min} shall be determined to verify that it does not change by more than the value specified in **6.4** when the maximum torque M_{max} is applied.

A-2.6 Built-in Temperature Conversion Device

A-2.6.1 *General*

A-2.6.1.1 All tests specific to the temperature conversion device shall be done on the same sample size as is used for the pattern approval of non- converting meters (*see* **A-2.1.2**).

A-2.6.1.2 The meters shall be subjected to tests at various constant temperatures according to **A-2.6.2**.

A-2.6.1.3 If the meters are to be approved for use under conditions in which the difference between the gas inlet temperature and the meter ambient temperature is larger than 10°C the meters shall be subjected also to the tests with intermittent operation.

A-2.6.2 *Constant Temperature Tests*

The meters shall be tested according to the procedure outlined in **A-2.4** with the exception that the test temperatures are the temperatures that follow from **6.5**.

A-2.7 Durability Test (*see* **8.2.3** and **8.2.4**)

A-2.7.1 If the meter is run for the durability test outside the laboratory of the approving authority it should be sealed completely.

A-2.7.2 The most important components of the gas measured during the durability test should be known.

A-2.7.3 The ambient conditions should not be more severe than those during normal operation of the meter.

A-2.7.4 For each meter, the meter reading at the beginning and at the end of the durability test shall be noted. The indication of the measured volume shall be verified as being compatible with the measured flowrate and the duration of test.

A-2.7.5 *Final Error Curve*

A-2.7.5.1 The final error curve shall be determined as soon as possible but not later than 48 h after termination of the durability test. During the time interval between termination and the determination of the error curve the meters shall remain shut off and filled with gas.

A-2.7.5.2 The conditions and the procedure for the determination of the final error curve shall be those of the initial performance test, as indicated in **A-2.3**. The test should be carried out on the same test installation as that in which the initial error curve was determined at.

A-2.7.5.3 The errors are determined twice, once with decreasing and once with increasing flowrate.

A-2.7.5.4 The shift of the mean error curve shall be within the tolerances specified in **8.2.4**.

A-2.7.6 If the pressure absorption at Q_{min} changed significantly the meter should be examined for the possible cause.

A-2.8 Conclusion

If the meters submitted for pattern approval are shown to comply with all the relevant requirements a pattern approval certificate shall be issued in accordance with **12.1.4** of IS 14439 (Part 1).

A-3 INITIAL VERIFICATION

A-3.1 Preparation

A-3.1.1 The meters shall be stabilised at the temperature of the test room.

A-3.1.2 If meters are brought into the test room from a room at a higher temperature, care shall be taken to avoid the condensation of water in the meters.

A-3.1.3 If meters are provided with mechanical indicating devices the roll-over of all index drums should be checked prior to or during the examination.

A-3.1.4 Prior to the testing, all markings and inscriptions on the meter shall be examined.

A-3.1.5 Prior to the testing, the meter shall be checked to verify that it conforms to the approved pattern.

A-3.1.6 The meters to be tested should be ready for operation according to the manufacturer's operating instructions.

A-3.1.7 Meters shall be installed on the test installation in accordance with the manufacturer's operating instructions. Pipes connected to the inlet and outlet of the meter should be of the same nominal size as the meter connections.

A-3.1.8 Meters having additional devices should be checked to ensure that these devices are connected properly and that they conform to the documents supplied by the manufacturer.

A-3.2 Test Procedure

A-3.2.1 After a meter to be tested, is installed in the test installations, it is brought to the minimum or maximum gauge pressure of the test installation, whichever is applicable. After temperature stabilisation the leak rate shall be less than 0.1 percent of the lowest flowrate at which the meter will be tested.

A-3.2.2 Before the start of testing, the meter should be run in at maximum flowrate. The volume passed through the meter should be at least 50 times the cyclic volume of the meter.

A-3.2.3 The meter shall be tested at least at the flowrates specified in **9.2**. The actual flowrate shall not differ by more than 5 percent from the nominal value.

A-3.2.4 The meter shall be tested preferably with a volume of air that equals an integer multiple of the cyclic volume of the meter. If this is not possible the volume of air passing through the meter shall be chosen so that the influence of the variation of the cyclic volume is less than 0.2 percent for the tests at flowrates equal to or greater than 0.1 Q_{max} and 0.4 percent for the tests at flowrates less than 0.1 Q_{max}.

A-3.2.5 At each flowrate the error shall be within the maximum permissible errors specified in **6.1** and **6.2**.

A-3.2.6 During the test at Q_{max} the pressure differential between the inlet and the outlet of the meter shall be read to check that the average total pressure absorption of the meter complies with **7**.

A-3.2.7 If a number of meters are tested in series the average inlet pressure at each meter shall be measured in order to be able to account for the effect on the measured volume of the decreasing pressure in the test line.

A-3.2.8 If a meter is tested without the indicating device or with a device replacing the indicating device at least one test shall be repeated with the indicating device fitted to the meter. Preferably this test shall be at a flowrate of 0.2 Q_{max}. The quality of the indicating device and of the positioning of it on the meter can be judged by comparing the errors and the pressure absorptions of the two tests.

If the difference in errors is larger than 0.2 percent, all the accuracy tests shall be performed with the indicating device placed on the meter.

A-3.2.9 If the meter is equipped with a pulse generator, the number of pulses per unit volume shall be checked.

A-3.2.10 If the meter is equipped with output drive shafts to which no additional device is attached, these shafts shall be checked to verify that they are suitably protected against external interference [*see* **4.3.2.3** of IS 14439 (Part 1)].

A-3.2.11 If a meter is adjusted by changing gear wheels, it shall be re-tested, at least at one flowrate in order to check whether the correct gear wheels have been correctly installed. Preferably the re-test shall be at a flowrate of 0.2 Q_{max}. The quality of the positioning of the wheels can be judged by comparing the errors and the pressure absorptions of the two tests.

A-3.2.12 If a meter is sealed after the examination this sealing shall be done carefully, without damaging the meter and preferably without hammering.

A-3.3 Test Procedure for Built-in Temperature Conversion Devices

A.3.3.1 If the meters are of a pattern equipped with a built-in temperature conversion device a sample of meters out of the lot that has been tested according to **A-3.2** shall be tested at three constant temperatures as specified in **A-3.3.2**. The sampling scheme shall be based on the results from the pattern approval tests, and on additional information, for example, quality control information from the manufacturer or growing experience with the verification of the specific type of meter.

A-3.3.2 The sample meters shall be tested at the minimum metering temperature and at the maximum metering temperature as specified on the meter according to **5.1**(i) of IS 14439 (Part 1) and the mean value of the two. If this mean value is within 5°C of the test air temperature during the testing according to **A-3.2** the results from those tests can be used for the statistical sampling.

A-3.3.3 The temperatures of the meter ambience and the test air at the meter inlet shall be within 1°C, and shall be kept constant within ±0.5°C of a given temperature.

NOTE—The humidity of the test air shall be such that no condensation occurs.

A-3.3.4 The flowrate should be 0.2 Q_{max}.

ANNEX B

(*Clause* 8)

RECOMMENDED FORM OF PATTERN EVALUATION REPORT FOR DIAPHRAGM GAS METERS

B-0 GENERAL

B-0.1 General Data

Application No: (New/Modification)
Manufacturer:
Applicant:
Representative:

B-0.2 General Information on the Gas Meter(s)

G *Designation*	Q_{max} (m^3/h)	Q_{min} (m^3/h)	P_{max} (kg/cm^2)	*V* (dm^3)

Type of display : Mechanical/Electromech/LCD/LED/...
Number of drums/figures :
Additional devices :
—prepayment device : Yes/No
—pulse generator : Yes/No... pulses/m^3/pulse
—number of output drive shafts
Built in conversion : Yes/No [ ] for temperature with
[ ] one indicating device
[ ] two indicating devices

B-0.3 Overall Result of the Pattern Evaluation

a) Documents and submitted meters ☐ 1)
b) General inspection ☐
c) Initial performance test ☐
d) Additional devices ☐
e) Built-in temperature conversion device ☐
f) Durability test ☐

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1) mark '+' (plus) when the result meets the requirements of IS 14439 (Part 1) and this standard.
Mark '−' (minus) when the result does not meet the requirements of IS 14439 (Part 1) and this standard.
Final result : Approved/Not approved.

B-1 DOCUMENTS AND SUBMITTED METERS

B-1.1 List of Submitted Documents

[*see* 12.1.3 of IS 14439 (Part 1)]

Declaration of conformity with safety regulations

[*see* 12.1.3 of IS 14439 (Part 1)] Yes/No

B-1.2 List of Submitted Meters (*see* 8.1)

G Designation	*Manufacturer's Serial Number*

B-1.3 Meters and Documents Compatible: Yes/No

B-2 GENERAL INSPECTION

B-2.1 Inscriptions on the Meters

[*see* 4.3.1, 4.3.2, 5.1 and 6.1.1.3 of IS 14439 (Part 1)]

B-2.1.1 *Display Panel/Data Plate*

— approval sign of the gas meter :
— maker's trade-mark/trade name :
— serial number and year :
— G designation :
— Q_{max} : m^3/h
— Q_{min} : m^3/h
— P_{max} : kg/cm^2
— V : dm^3
— t_m : °C
— p_m : kg/cm^2

B-2.1.2 *Additional Devices*

— pulse generator : imp/m^3 or m^3/imp
— output drive shaft : N-mm

B-2.1.3 *Conversion Devices*

— t_b : °C
— p_b : kg/cm^2

B-2.1.4 *Other Indications*

— symbol 'm^3' : Yes/No
— flow direction indication : Yes/No

B-2.2 Check on Location of Sites for Verification and Protection Marks: ☐

B-2.3 Indicating Device(s), Test Element(s)
[*see* 6.1 and 6.2 of IS 14439 (Part 1)]

a) General construction ☐

b) Test element ☐
c) Diameter drums/dials ☐
d) Reading of indicating device ☐
e) Advance of figures ☐
f) Removal of indicating device ☐

B-3 INITIAL PERFORMANCE TEST

Ambient conditions t = ...°C ±....°C
RH = ... percent

B-3.1 Error Curve (*see* **6.1**, **6.2** and **8.2.2**)

Running in: ...... m^3 at .... m^3/h.

Flowrate (m^3/h)	*Measured Volume* (m^3)	*Errors* (%)	*Mean Error*(%)	*Standard Deviation* (%)	*Tolerance* (%)	*Result* ±
Q_{max}						
0.7 Q_{max}						
0.4 Q_{max}						
0.2 Q_{max}						
0.1 Q_{max}						
3 Q_{min}						
Q_{min}						

General result for error curve: ☐

B-3.2 Average Total Pressure Absorption at Q_{max}: .. kg/cm^2
Tolerance: ..kg/cm^2 (*see* 7)
Result: ☐

B-3.3 Pressure Absorption at Q_{min}: kg/cm^2

B-3.4 Standard Deviation (*see* **5.1**)

Flowrate: ...m^3/h (about 0.1 Q_{max})

Air volume per measurement: ... dm^3

Test No.	*Indicated Volume* (dm^3)	σ (dm^3)	σ^2
1			
2			
3			
4			
5			
27			
28			
29			
30			

Mean indicated volume : ..... dm^3
Standard deviation : ..... dm^3
Tolerance : ..... dm^3
Result : ☐

B-4 ADDITIONAL DEVICES

B-4.1 Prepayment Device [*see* 4.3.1 of IS 14439 (Part 1)]

Influence of prepayment device on meter performance : ☐

B-4.2 Pulse Generator [*see* 4.3.1 of IS 14439 (Part 1)]

Proper working: ☐
Number of pulses per unit volume correct: ☐

B-4.3 Output Drive Shafts (*see* **6.4** and **8.2.5**)

Maximum torque to be applied M_{max} = ... N. mm
Application of 3 M_{max} :
Connection between measurement device and gearing remains intact :
Application of M_{max} at Q_{min} : Error at Q_{min} originally : ..... %
Error at Q_{min} with M_{max} : ..... %
Difference : ...... %
Tolerance :...... %
Result : ☐

B-5 BUILT-IN TEMPERATURE CONVERSION DEVICE

B-5.1 List of Submitted Meters

G-Designation	*Manufacturer's Serial Number*

Indicated temperature range: t_m = ...to... °C

B-5.2 Constant Temperature Tests

Test temperatures : a) ..... °C
b) ..... °C
c) ......°C
d) ..... °C

B-5.2.1 *Increasing Temperature*

Flowrate (m^3/h)	*Errors* (%) at			
	$t = \ldots$ °C	$t = \ldots$ °C	$t = \ldots$ °C	$t = \ldots$ °C
0.2 Q_{max}				
0.7 Q_{max}				
Q_{max}				

B-5.2.2 *Decreasing Temperature*

Flowrate (m^3/h)	*Errors* (%) at			
	$t = \ldots$ °C	$t = \ldots$ °C	$t = \ldots$ °C	$t = \ldots$ °C
0.2 Q_{max}				
0.7 Q_{max}				
Q_{max}				

B-5.2.3 *Increasing Temperature*

Flowrate (m^3/h)	*Errors* (%) at			
	$t = \ldots$ °C	$t = \ldots$ °C	$t = \ldots$ °C	$t = \ldots$ °C
0.2 Q_{max}				
0.7 Q_{max}				
Q_{max}				

Result constant temperature tests: ☐

B-6 DURABILITY TEST (*see* **8.2.3** and **8.2.4**)

B-6.1 Meter Completely Sealed : Yes/No

B-6.2 Test Medium: Gas

Gas composition :

a) CO_2 = ...mol %
b) N_2 = ...mol %
c) CH_4 = ...mol %
d) C_2H_6 = ...mol %
e) RH = ... %

B-6.3 Ambient Conditions at Test Site

a) Ambient temperature: .....°C
b) Environmental classification : B/C/F

B-6.4 Data Durability Test

Flowrate: ..... m^3/h
Duration: ..... hours

Meter Number	*Meter Reading*		*Measured Volume* (m^3)
	At Beginning	At End	

Date and time of termination of durability test: .....

B-6.5 Final Error Curve

Date and time of determination of error curve:

Flowrate (m^3/h)	*Measured Volume* (m^3)	*Errors* (%)	*Mean Error* (%)	*Shift* (%)	*Tolerance* (%)	*Result* ±
Q_{max}						
0.7 Q_{max}						
0.4 Q_{max}						
0.2 Q_{max}						
0.1 Q_{max}						
3 Q_{min}						
Q_{min}						

General result for error curve shift: ☐

B-6.6 Pressure Absorption at Q_{min} : ...kg/cm^2

Change : ...kg/cm^2

B-6.7 Average Total Pressure Absorption at Q_{max} : ...kg/cm^2

Change : ...kg/cm^2

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This Indian Standard has been developed from Doc: No. LM 06 (0277).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Printed at Simco Printing Press, Delhi, India